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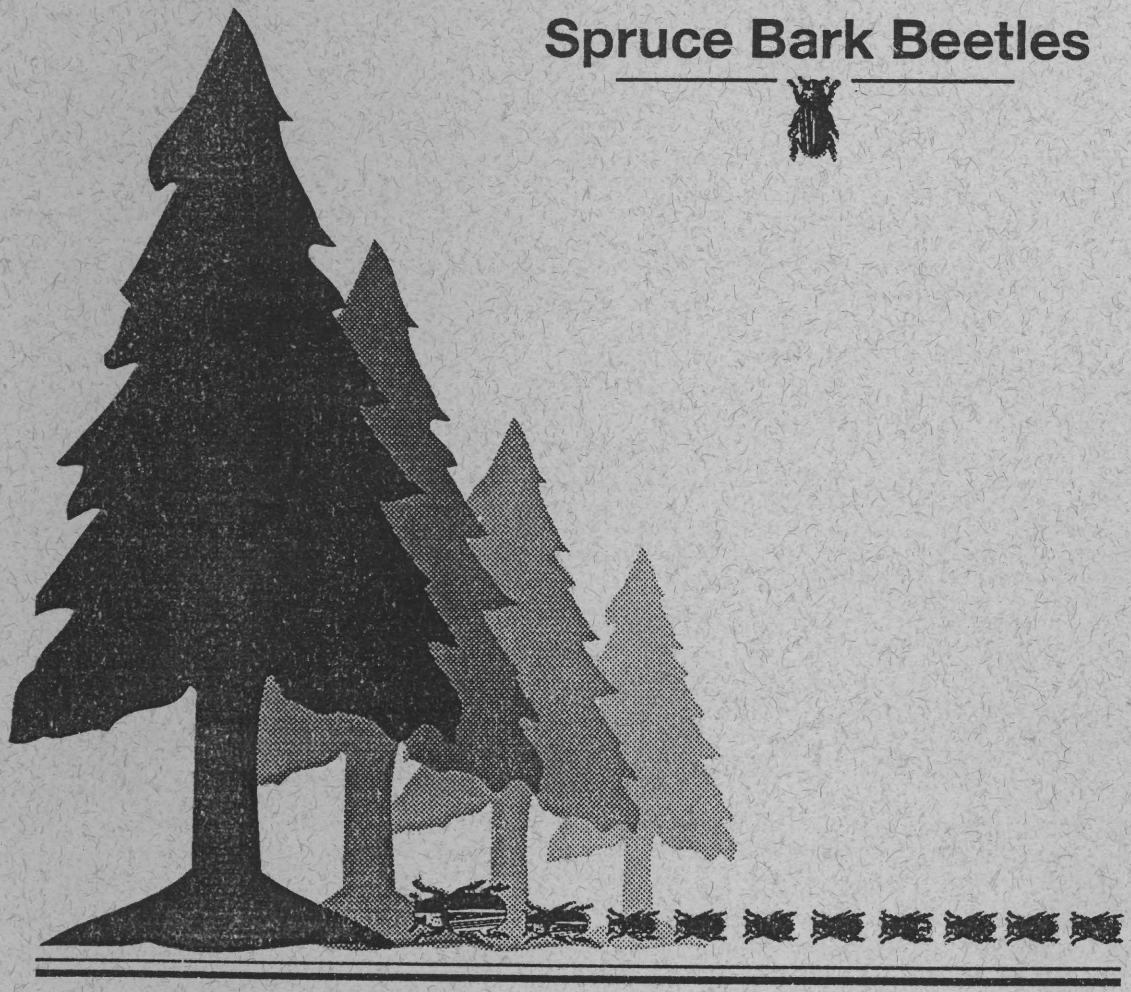
Suitability of Powerline Right-of-Way Clearing Debris as Breeding Material for Spruce Bark Beetles



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3430

TECHNICAL REPORT R10-TP-49
SUITABILITY OF POWERLINE RIGHT-OF-WAY CLEARING DEBRIS AS BREEDING MATERIAL FOR SPRUCE BARK BEETLES

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INTRODUCTION:

The spruce beetle, *Dendroctonus rufipennis* (Kirby), is the most significant natural mortality agernt of mature spruce in North America. Outbreaks of this beetle have caused extensive spruce mortality from Alaska to Arizona and have occurred in every forest with substantial spruce stands. Spruce beetles continue to impact vast areas in Alaska. In 1987, on-going infestations were impacting approximately 225,000 acres of spruce; throughout south-central Alaska. By 1993, on-going infestations expanded to more than 700,000 acres (Hennon et al. 1994).

Endemic populations of spruce beetles live and breed in windthrown trees (App. A). When beetle populations increase to high levels in down trees, dispersing beetles may enter susceptible, large diameter, standing timber if adequate amounts of downed trees are not available (Holsten et al. 1991). Most spruce beetle outbreaks in standing timber originate in windthrown trees, although logging residuals--especially cull logs from logging areas, right-of-way (ROW) lines, or seismic operations can be contributing factors (Holsten 1994).

Shaded windthrown trees at the sheltered edges of clearing activities and throughout the forest produce large numbers of maturing beetles. Shaded windthrown trees are the most productive habitat for breeding spruce beetles; a shaded windthrown tree can produce 5X the beetles as a standing infested tree (Dyer & Taylor 1971, Schmid & Frye 1977). Unpublished data from the Rocky Mountain Region indicate that shaded windthrown spruce can remain attractive through two attack periods (Schmid & Frye 1977). If a windthrown spruce is partially infested during the first possible attack period, then additional infestation is unlikely one year later. Logging residuals, on the other hand, are thought to be suitable for infestation only during the first possible attack period (Schmid & Frye 1977). Logging slash has been shown to be an excellent breeding site during the first season after logging. Brood survival, however, in the second season is usually low. The ratio of progeny to attack is much higher in windthrown trees than in slash and survival in the second year is also much greater in windthrown trees (Dyer & Taylor 1971).

As previously mentioned, most Alaska spruce beetle outbreaks originate from breeding material such as blowdown or seismic or powerline right-of-way (ROW) clearing activities (Werner 1978). For example, a large outbreak was detected in 1972 on the westside of Cook Inlet and by 1973 covered more than 200,000 acres (Holsten 1990). The cause of the outbreak was not definitely known but is believed to be associated with the seismic line clearing debris.

There has been increasing powerline ROW clearing activities throughout south-central Alaska for the past 15 years (Holsten 1980, 1981, 1982, 1990). Most powerline ROW clearing debris is limbed, bucked and left scattered throughout the ROW clearing. A variety of recommendations from peeling to the burning of clearing debris has been suggested as techniques to treat this potential breeding material (Holsten 1990). Powerline ROW clearing debris was thought to be a risk as potential breeding habitat for two seasons, although there were no data to support this belief (Holsten 1980). Ground inspections of ROW clearing debris are both time-consuming and costly.

OBJECTIVE:

A study was undertaken to determine if ROW clearing debris, if unattacked the first possible attack period, could be successfully attacked the following season.

MATERIALS & METHODS:

Ten Lutz spruce (*Picea* x *lutzii*) were felled and bucked in the Summit Lake area of the Kenai Peninsula on 5-28-93. The trees were bucked to a 10' length similar to ROW clearing debris. Top and bottom diameters of the study trees averaged 8.7 and 11.1 ", repectively (Fig. 1).

Figure 1. Top and bottom diameter, in inches, of the ten study trees.

TREE	TOP	BOTTOM
1	9.4	12.8
2	7.1	8.9
3	11.0	13.4
4	9.8	10.8
5	8.8	10.8
6	6.3	9.5
7	9.3	12.5
8	7.5	9.0
9	7.5	10.0
10	10.3	13.0
AVERAGE	**8.7**	**11.1**

Five logs were randomly selected and left in the woods to be attacked by the 1993 spruce beetle population (1993-logs: 3,1,4,10 and 6). The remaining five logs (1994-logs: 2,7,5,8 and 9) were taken to Broadview Guard Station, approximately 15 miles from Summit Lake, and stored in a screened porch away from attacking beetles. In theory, these unattacked logs would be replaced in the woods at the end of the 1993 flight season. However, most of the five 1994- logs became lightly attacked inside the screened porch. These logs were checked daily for evidence of attack (frass). Attacking adults were removed from the logs as best as possible. Locations of attacks were marked on the logs so as not to sample these areas the following season.

The five 1993-logs which were left in the woods were sampled on 7-23-93. Two pairs of 6" x 6" bark samples were removed from mid-line of each log at least 1.5 ft from each end. The following information was collected from each sample: # of spruce beetle eggs, # of spruce beetle larvae, # of spruce beetle pupae, # of spruce beetle adults, # of spruce beetle attacks, and # of spruce beetle galleries. The occurrence of *Ips* adults and galleries was noted. In August of 1993,

the five 1994-logs, housed in the screened porch, were transferred to the study site and left next to the recently sampled logs. These five 1994-logs were then sampled on 8-2-94.

RESULTS AND DISCUSSION:

As seen in Figures 2 & 3, the logs left in the woods during the 1993 flight season (1993-logs) averaged 25 spruce beetle progeny per 6" x 6" sample (Fig. 2). More than 50% of the progeny were new adults indicating a one year life cycle. These five logs were left in the woods during the winter of 1993/94. During the 8/94 sampling, these 1993- logs were also re-examined. Almost 100% of the phloem had been consumed by spruce beetle brood and the logs were extremely dry; i.e. not suitable for attack in 1994. This is similar to the findings of Schmid & Frye (1977).

The five logs that were kept in the screened porch during the 1993 flight season (1994-logs) were placed next to the 1993-logs in the late summer of 1993, after beetle flight. These 1994-logs were then sampled in August of 1994. As seen in Fig. 3, these 1994-logs, for the most part, were not attacked by spruce beetles. Only 5 samples out of 20, had spruce beetle progeny. Spruce beetle progeny from 1994 attacks averaged 1.7 per sample versus 25 per sample in 1993. Surprisingly, most of these 1994-logs were heavily attacked by *Ips* beetles. *Ips* can develop in trees with lower moisture content than required by spruce beetles. The species of *Ips* most commonly encountered appears to be *I. tridens*; a species not noted as a tree-killer. All 20 1994 samples had *Ips* progeny, usually pupae or callow adults.

Based on the results from this preliminary study, it appears that limbed and bucked logs, if not attacked during the first spruce beetle dispersal flight, are significantly less productive as breeding material if attacked the second flight season. There appears to be no reason to check scattered right-of-way clearing debris more than once. If this material is yarded along the shaded edges of a ROW clearing, it could then remain attractive for two years. However, this material appears the remain attractive and productive as breeding material for *Ips* beetles. There could be some limited tree mortality associated with a large emerging *Ips* population. The risk of tree mortality caused by *I. tridens*, however, is much less than that of the spruce beetle.

Figure 2. Spruce beetle progeny, by log section from the 1993-logs; 7-23-93.

YEAR	# LOG	# SECT	# EGG	# LAR	# PUP	# ADU	# ATT	# GALL	NOTES
7/93	3	A	--	5	--	4	6	13	
		B	--	6	--	9	5	12	
		C	--	9	--	4	2	2	IPS
		D	--	19	--	17	10	18	
	1	A	--	21	--	17	8	19	
		B	--	9	--	17	7	16	
		C	--	5	--	17	9	17	
		D	--	31	--	16	9	15	
	4	A	--	15	--	20	8	16	
		B	--	--	--	2	--	3	IPS
		C	--	--	--	10	2	6	
		D	--	12	--	10	5	14	
	10	A	--	11	--	13	11	16	
		B	--	11	--	11	7	16	
		C	--	7	--	30	14	18	
		D	--	--	--	--	--	--	
	6	A	--	43	--	16	10	15	
		B	--	9	--	22	15	22	
		C	--	7	1	11	4	19	
		D	--	9	--	28	10	22	
AVERAGE			**0.0**	**12.0**	**0.0**	**13.7**	**7.1**	**14.0**	

Figure 3. Spruce beetle progeny, by log section from the 1994-logs; 8-2-94.

YEAR	# LOG	# SECT	# EGG	# LAR	# PUP	# ADU	# ATT	# GALL	NOTES
8/94	2	A	--	--	--	--	--	--	IPS
		B	--	--	--	--	--	--	IPS
		C	--	--	--	--	--	--	IPS
		D	--	--	--	--	--	--	IPS
	7	A	--	--	--	--	--	--	IPS
		B	--	--	--	--	--	--	IPS
		C	--	--	--	--	--	--	IPS
		D	--	--	--	1	1	1	IPS
	5	A	--	--	--	--	--	--	IPS
		B	--	1	--	--	--	--	IPS
		C	--	--	--	--	--	--	IPS
		D	--	--	--	--	--	--	IPS
	8	A	--	--	--	--	--	--	IPS
		B	--	--	--	3	1	1	IPS
		C	--	--	--	--	--	--	IPS
		D	--	--	--	--	--	--	IPS
	9	A	--	--	--	--	--	--	IPS
		B	--	--	--	1	1	1	IPS
		C	20	--	--	1	1	1	IPS
		D	=	=	=	=	=	=	IPS
AVERAGE			**1.0**	**--**	**--**	**0.3**	**0.2**	**0.2**	

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APPENDIX A

SPRUCE BEETLE

Dendroctonus rufipennis (Kirby)
(Coleoptera:Scolytidae)

HOSTS: White, Sitka, Lutz and rarely Black Spruce.

DISTRIBUTION: Wherever spruce is found. A serious forest pest in south-central Alaska throughout Cook Inlet and the Kenai Peninsula.

DAMAGE: Larvae feed beneath bark, usually killing affected trees.

DESCRIPTION: Adult spruce beetles are maroon to black, cylindrical in shape, approximately 5 mm long and 3 mm wide. Larvae are stout, white, legless grubs, 6 mm long when full-grown. The pupae are soft-bodied, white, and have some adult features.

BIOLOGY: The life cycle of the spruce beetle may vary from one to three years, with a two-year cycle being the most common. Temperature plays an important part in determining the length of time required for beetle development.

Adult beetles become active in the spring (late May--early June) when air temperatures reach a threshold of 16° C (61° F). At this time, beetles emerge from trees in which they overwinter and fly in search of new host material. These dispersal flights may be short-range even though beetles are capable of flying for several miles without stopping.

Spruce beetles prefer to attack the sides and bottom surfaces of windthrown or other down materials which have been on the ground less than one year. In the absence of such host material, large-diameter live trees may be attacked instead, and if beetle populations are high, these trees may be killed.

Beetle attacks, whether on windthrown or on standing timber, are mediated by pheromones which insure that individual trees will be attacked "en masse", and fully colonized by subsequent broods. Trees that are mass-attacked form attractive centers which result in groups of trees being killed by spillover attacks.

Female beetles initiate attacks and begin constructing an egg gallery in the cambium parallel to the grain of the tree. They are joined by males and after mating, lay eggs in small niches along the sides of the egg gallery. Most eggs will hatch by August. As they feed in the cambium, larvae construct their own galleries perpendicular to the egg gallery. Normally, spruce beetles pass the first winter in the larval stage, resume feeding the next spring, and pupate by summer. About two weeks later, pupae transform into adults which pass the second winter, either in old pupation sites, or more commonly, in the bases of infested trees. The following spring, two years after

initial attack, the new adults emerge and attack new host material. In some years when temperatures are above average, or on certain warm microsites, spruce beetles may complete their development within one season and new adults will emerge one year after attack.

Most major outbreaks of spruce beetles have originated from stand disturbances--blowdown, logging, or right-of-way clearance. Stand susceptibility to beetle attack is influenced by stocking, with slow growth and moisture stress playing an important part in predisposing trees to attack.